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(54) METHOD OF PRODUCING AN ARTICLE IMPREGNATED WITH
 THERMOSETTING RESIN



(71) We, SHELL INTERNATIONALE RE-
 SEARCH MAATSCHAPPIJ N.V., a company
 organized under the laws of the Nether-
 lands, of 30 Carel van Bylandtlaan, The
 Hague, the Netherlands, do hereby declare
 the invention, for which we pray that a pat-
 ent may be granted to us, and the method by
 which it is to be performed, to be particu-
 larly described in and by the following state-
 ment:—

The invention relates to a method of pro-
 ducing an article impregnated with thermo-
 setting resin. In Patent Specification No.
 1,266,097 a method of producing an article
 impregnated with thermosetting resin is pro-
 posed, which comprises impregnating a sheet
 having an open-cell foam structure with a
 curable thermosetting resin, applying a layer
 of fibrous reinforcing material to a side of
 the impregnated foam sheet, compressing
 the foam sheet and fibrous reinforcing layer
 to the extent that the resin is expelled from
 the sheet into the fibrous reinforcing layer
 so as to impregnate this layer with resin
 throughout its thickness, and allowing the
 resin in the sheet and layer to cure whilst
 maintaining the compression.

In accordance with the present invention,
 the compression of the assembly formed by
 the impregnated foam sheet and fibrous re-
 inforcing layer takes place in an enclosed
 space and is effected by the expansion pres-
 sure of a foaming composition. The present
 method has the advantage that no special
 compression means are required to compress
 the assembly formed by the resin impregna-
 ted foam sheet and fibrous reinforcing layer,
 because the expansion pressure of a foaming
 composition is used for this purpose. Fur-
 thermore, the resulting product, which con-
 sists of a layer of foamed material formed
 by the foaming composition with a rigid fac-
 ing formed by the compressed original resin
 impregnated foam sheet and resin-impregna-
 ted fibrous reinforcing material, is particu-

larly useful for many applications. Depend-
 ing on the intended use of this product, the
 foaming composition can be selected so as
 to produce a foam which is rigid, flexible,
 or semi-flexible.

The foaming composition is preferably a
 composition capable of forming a polyureth-
 ane foam, and the invention is herein de-
 scribed using a composition of this kind.
 However, it is to be understood that any
 foaming composition capable of generating
 the required expansion pressure may be used,
 example being compositions forming a
 foamed rubber or foamed urea-formaldehyde
 resin.

The foaming polyurethane composition
 can be in direct contact with the impregna-
 ted foam sheet, whereby a small amount of
 the composition will penetrate into the foam
 sheet and thereby improve anchorage of the
 polyurethane foam to the other layers. If
 penetration of the polyurethane into the foam
 sheet is not desired, or, for any other reason,
 one or more intermediate layers of material
 may be placed between the foaming poly-
 urethane composition and the assembly
 formed by the impregnated foam sheet and
 fibrous reinforcing layer. These intermediate
 layers can be sheets or films of paper or of
 thermoplastic material, or webs or tissue of
 fibrous material such as made of textile or
 glass fibre.

In order that the expanding polyurethane
 foam may develop full pressure on the foam
 sheet, the expansion takes place in an en-
 closed space, normally a closed mould. The
 assembly formed by the impregnated foam
 sheet and fibrous reinforcing layer is placed
 in the mould, usually with the fibrous rein-
 forcing layer against the moulding surface
 of the mould. A mould release agent may
 have been applied to the moulding surface to
 facilitate the removal of the final product
 from the mould. The mould can have any de-
 sired shape; for example, the mould may

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have two moulding surfaces extending parallel to each other either straight or in a curved direction so that the product being moulded will be a straight or curved article. Once the assembly is placed in the mould, the polyurethane foam forming composition is poured or sprayed (or injected, if the mould is already closed) as an unfoamed liquid or as a partly foamed liquid (froth) in the desired quantity in the open space remaining in the mould. The mould, if still open, is then closed, and the liquid composition is permitted to foam to the fullest possible extent, whereby an expansion pressure may be generated in the order of 0.5 kg/cm² or more, which is adequate to compress the impregnated foam sheet and to drive out the resin therefrom into the fibrous reinforcing layer so as to impregnate this layer throughout its thickness.

After the polyurethane foam and the thermosetting resin in the remaining part of the product have cured to the desired extent, the mould is opened and the product removed therefrom. The product comprises at least the following layers: a rigid layer of fibre-reinforced hardened thermosetting resin, a rigid layer of compressed foam sheet filled completely or substantially with hardened resin, and a layer of polyurethane foam. Normally, the thickness of the layers filled with the thermosetting resin is small as compared with the thickness of the polyurethane foam layer, so that these first layers actually form a hard and rigid skin, on the polyurethane foam.

Various other arrangements are possible. For example, a sandwich-like construction can be produced in which the polyurethane foam layer is covered at both sides with a rigid skin. For this purpose, the assembly formed by the impregnated foam sheet and fibrous reinforcing layer is placed near one side of the mould, and another such assembly is placed at some distance from the first one near another side of the mould. Preferably, the fibrous reinforcing layer in each assembly is facing the side of the mould where the assembly is placed. The mould cavity left between the two assemblies is then filled to the desired volume with the polyurethane foam forming composition.

The products resulting from this invention are suitable for a wide range of uses, such as for making body elements for motor cars and aircraft (seats, doors, panels, crash pads), boat hulls, furniture and skis.

Example

An impregnated foam sheet was made by passing a 5 mm thick sheet of flexible open-celled polyurethane foam through a bath containing a liquid epoxy resin system. In the bath, the sheet was compressed followed by expansion to soak it with resin. Excess resin

was expelled from the sheet by passage through a pair of squeeze rollers. A layer of fibrous reinforcing material formed by a mat of glass fibres was placed on either side of the impregnated foam sheet, and the assembly was then placed in a mould. The mould was formed with two parallel moulding surfaces 63 mm apart and about 90 cm long. The moulding surfaces had been coated with a mould release agent, and the assembly was placed against one of these surfaces. In the mould, two glass fibre surface tissues were laid on the exposed surface of the assembly. The assembly plus tissues had a total thickness of about 8 mm. In the open space of the mould i.e. the space between the assembly plus tissues and the other moulding surface, some 55 mm wide, a homogeneously mixed composition capable of forming a rigid polyurethane foam was poured, and the mould was then closed. The polyurethane forming composition consisted of 100 parts of polyol, 135 parts of di-isocyanate, and 20 parts trichloromonofluoromethane (all parts by weight). The mould was left closed for 20 minutes without the supply of external heat. Accordingly, the epoxy resin system was allowed to cure at room temperature, although, if desired, the curing process can be accelerated by heating of the mould to about 50°C. After the product was taken from the mould, it was found that the original impregnated foam sheet with glass fibre layers had formed a rigid skin of 2—3 mm thickness on the polyurethane foam.

WHAT WE CLAIM IS:—

1. Method of producing an article impregnated with thermosetting resin, comprising impregnating a sheet having an open-cell foam structure with a curable thermosetting resin, applying a layer of fibrous reinforcing material to a side of the impregnated foam sheet, compressing the foam sheet and fibrous reinforcing layer to the extent that resin is expelled from the sheet into the fibrous reinforcing layer so as to impregnate this layer with resin throughout its thickness, and allowing the resin in the sheet and layer to cure whilst maintaining the compression, as claimed in Patent Specification No. 1,266,097 wherein the compression of the assembly formed by the impregnated foam sheet and fibrous reinforcing layer takes place in an enclosed space and is effected by the expansion pressure of a foaming composition.

2. Method as claimed in claim 1, wherein the foaming composition is in direct contact with the impregnated foam sheet.

3. Method as claimed in claim 1, wherein between the foaming composition and the assembly one or more other layers are placed.

4. Method as claimed in claim 1, wherein the assembly is placed with the fibrous re-

inforcing layer facing one side of the mould, another such assembly is placed with its fibrous reinforcing layer facing another side of the mould, and the foam forming composition is poured in the mould space between these assemblies.

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5. Method as claimed in any one of the preceding claims, wherein the foaming composition is a composition capable of forming a polyurethane foam.

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6. Method as claimed in claim 1, sub-

stantially as hereinbefore described with particular reference to the Example.

7. Article impregnated with thermosetting resin, produced in accordance with the method of any one of the preceding claims. 15

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